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(54) Optical communication system

(57) A two way optical communication system comprises two light transmitter/receiver stations positioned at spaced apart locations and arranged to afford communication through free space therebetween, wherein one only of the two stations, hereinafter called the proximal station comprises a single beam light transmission source 31, 32, and wherein the other of the two stations, hereinafter called the distal station, comprises retro-reflector means 42 and modulator means 41 utilised for the transmission of data from the distal station to the proximal station by reflecting a light carrier signal originating from the light transmission source back to a receiver at the proximal station, this retro-reflected carrier signal being modulated to carry the data, the distal station further including an optical detector 40.

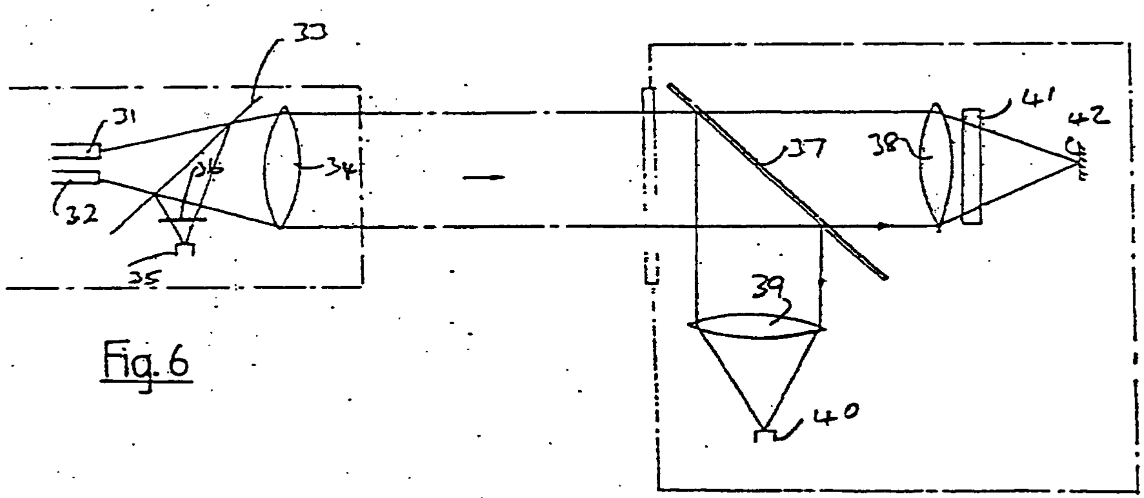

Fig. 6

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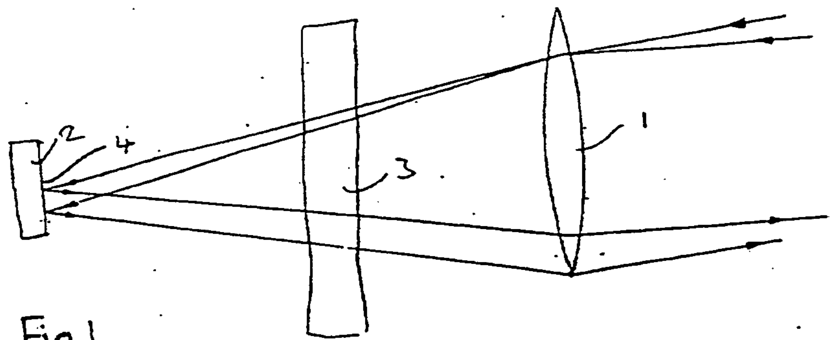

Fig.1

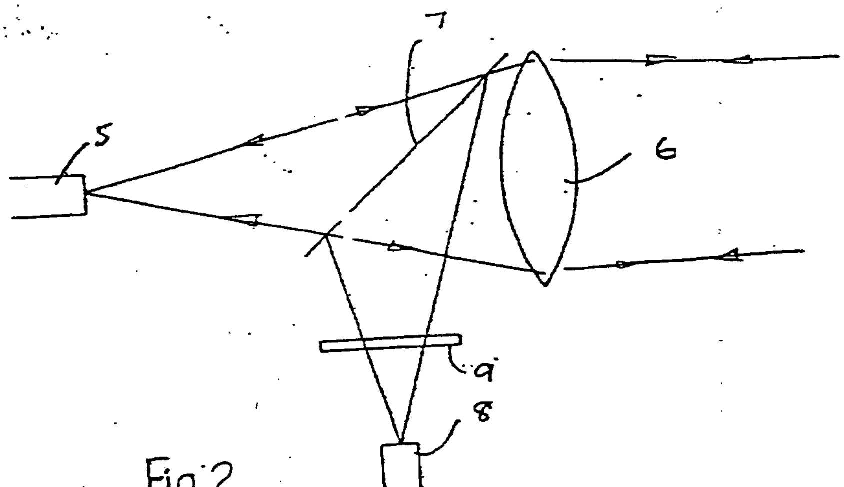

Fig.2

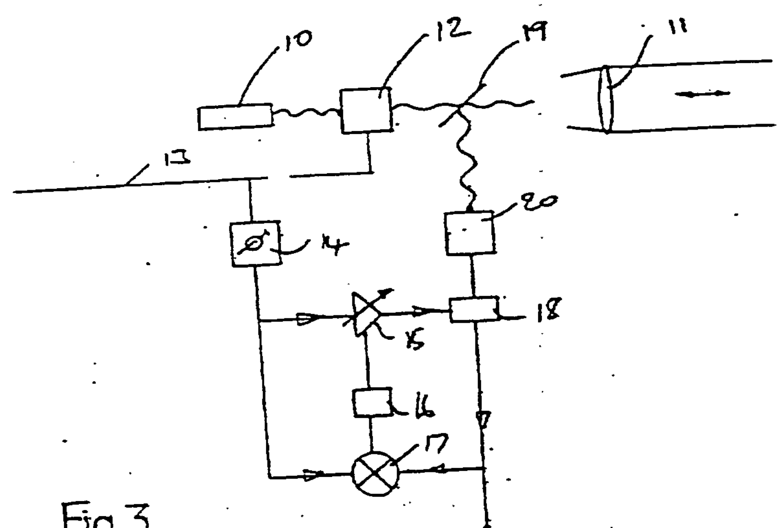

Fig.3

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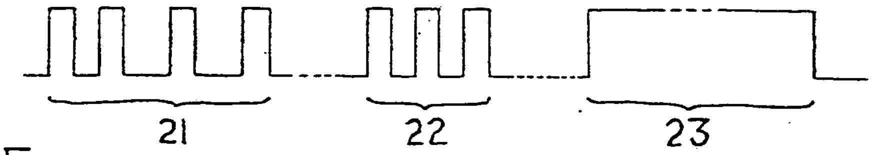

Fig.4

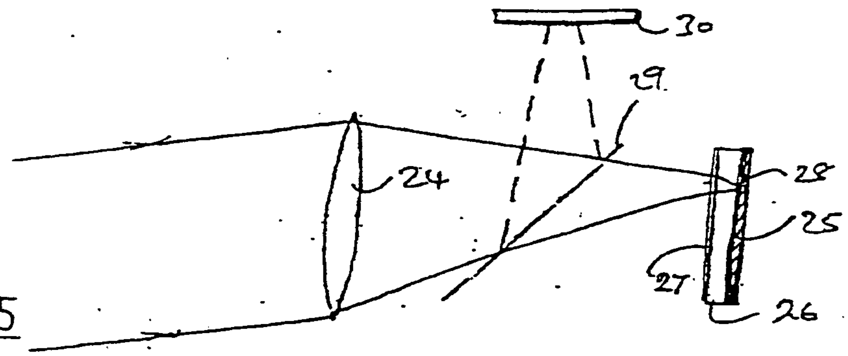

Fig.5

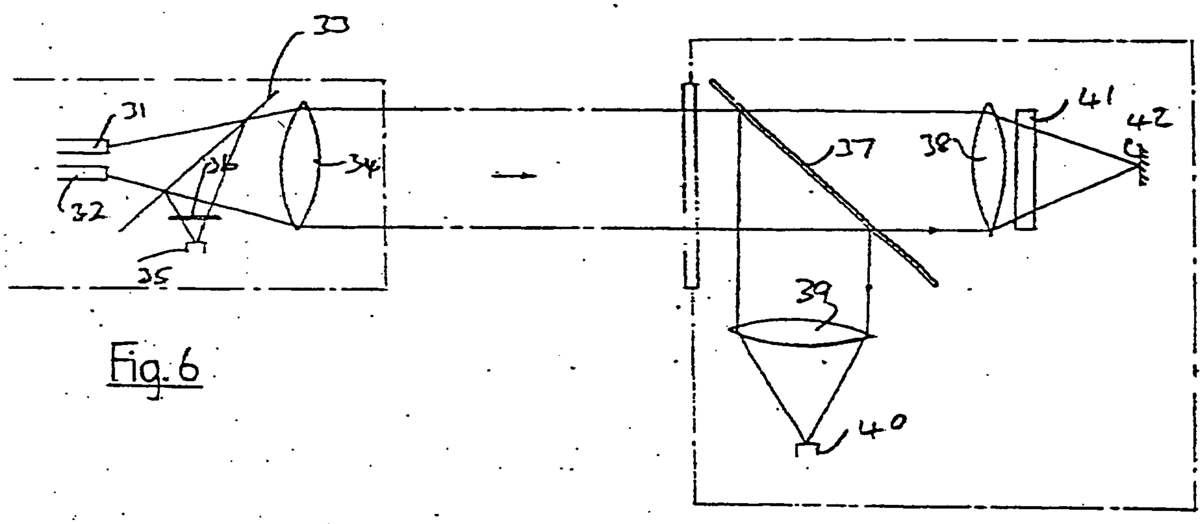

Fig.6

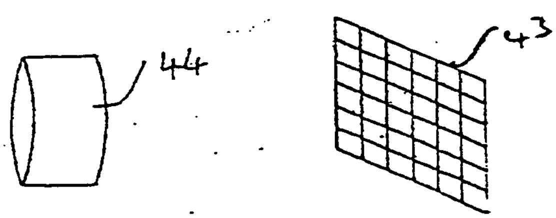

Fig.7

SPECIFICATION

Optical communication system

This invention relates to optical communication systems.

According to the present invention, an optical communication system comprises two light transmitter/ receiver stations positioned at spaced apart locations and arranged to afford communication therebetween, wherein one only of the two stations, hereinafter called the proximal station comprises a light transmission source, and wherein the other of the two stations, hereinafter called the distal station, comprises retro-reflector means and modulator means utilised for the transmission of data from the distal station to the proximal station by reflecting a light carrier signal originating from the light transmission source back to a receiver at the proximal station, this retro-reflected carrier signal being modulated to carry the data.

The system may afford one way data transmission from the distal to the proximal station. Alternatively the system may be a two way communication system.

A system according to the invention may thus comprise a distal station which consumes very little power since the carrier signal is arranged to originate at the proximal location, alignment between the two stations being achieved automatically when the two stations are in mutual communication.

The proximal transmitter/receiver and the distal transmitter/receiver may be arranged for duplex communication.

This may be achieved by arranging that different kinds of modulation are transmitted from each station, each station being arranged to include a receiver having a detector appropriate to the received modulation.

The modulation may be amplitude modulation, intensity modulation, polarisation modulation, phase modulation, frequency modulation or digital equivalents thereof. Alternatively duplex communication may be achieved by arranging that both stations use phase or frequency modulation and include coherent detection systems such that there is no mutual interference when both stations are transmitting at the same time.

According to an alternative embodiment of the invention, the two stations may operate in a simplex or time division multiplex mode whereby the stations are arranged to transmit alternately or at least never at the same time. The retro-reflector means may be effected by phase conjugation or by using light reflectors such as corner cubes or cat's eyes.

The term light when us d herein is intended to include light in the visible spectrum or in the non-visible spectrum.

The modulation may be impressed on the light carrier signal using, for example, Pockles, Kerr or Faraday cells, frustrated total internal reflection, electrochromic or liquid crystal cells.

Various embodiments of the invention will now be described by way of example with reference to the accompanying drawings in which:

Figure 1 is a block schematic diagram of optical apparatus at a distal station;

Figure 2 is a similar diagram of optical apparatus at a proximal station;

Figure 3 is a similar diagram of alternative optical apparatus and electronic arrangement at a proximal station;

Figure 4 is a waveform diagram showing one kind of pulse coded transmitted light signal;

Figure 5 is a block schematic diagram showing alternative optical apparatus at a distal station;

Figure 6 is a similar diagram showing optical apparatus for two channel communication between a proximal station and a distal station; and,

Figure 7 is a similar diagram showing optical apparatus including a photodetector array for use at a distal receiver station.

Referring now to the drawings, a system for communicating between a distal station and a proximal station comprises a distal station having an optical system as shown in Figure 1. The system comprises a lens 1 which is arranged to focus light transmitted from the proximal station (not shown) onto a detector 2 arranged in the focal plane of the lens, via a modulator 3. The detector 2 is used to demodulate signals transmitted from the proximal station and the modulator 3 is used to modulate light reflected from a surface 4 of the detector back to the proximal station.

Modulation at the proximal station may be amplitude modulation, intensity modulation, polarisation modulation, phase modulation, or frequency modulation or a digital equivalent of one of these modulation types which is imposed directly onto the carrier radiation or onto a sub-carrier at some lower frequency. The modulation imposed on the retro-reflected light by the modulator as shown in Figure 1 may be any one of these types although the type of modulation must be compatible with and separable from the modulation imposed at the proximal station.

Referring now to Figure 2 which shows schematically an optical arrangement suitable for use at the proximal station, the apparatus comprises a light source 5 which would in general comprise a laser transmitter such as a semiconductor laser or gas laser and a lens 6 for focussing light generated by the light source 5 onto a receiver at the distal location. Additionally, some mechanical or electro-optical means of tracking the laser direction in space may be provided although this is not shown in Figure 2. Light from the source 5 is radiated to the lens 6 via a beam splitter 7

which serves to reflect retro-reflected light received via the lens 6 from the distal station onto a detector 8 via a polariser 9. With the arrangement just before described the polariser 9 affords demodulation of a polarisation modulated signal from the distal station.

Alternatively as shown in Figure 3 if the data transmitted from the distal station is in the form of amplitude, frequency, or phase modulation, then an electronically coherent demodulation of the electronic signal may be employed. Referring now to Figure 3, this may comprise a light source 10 which is arranged to radiate light via a lens 11 to a receiver (not shown) at the distal station. The light is modulated by a modulator 12 in accordance with data provided on line 13 which is fed also via a delay device 14 to a coherent detector arrangement comprising a controlled amplifier 15, a filter 16, a mixer 17 and a differential amplifier 18. Light received from the distal station via the lens 11 is fed via a light splitter 19 to a light detector (not shown) in a receiver 20. Electrical output signals from the receiver 20 corresponding to the data transmitted from the distal station are fed to the differential amplifier 18 to effect detection of the received signal.

In an alternative arrangement, the transmitters at the proximal and distal stations may be arranged to operate alternately and in this case a wave form may be transmitted as shown in Figure 4 wherein the elements 21 comprise coded data in the form of a pulse train which are followed by elements 22 indicative of an end of text code. Thereafter a carrier wave signal 23 is transmitted from the proximal transmitter which serves as a carrier signal for retro-reflection and transmission from the distal transmitter.

Referring to Figure 5, in order to effect modulation of the received signal at a distal receiver, received light at the distal station may be focussed by means of a lens 24 onto a reflector 25 via a modulator 26 which is used to modulate retro-reflected light. The arrangement may optionally include a waveplate-polariser 27. In order to detect received signals, the reflector 25 may itself embody a photodiode detector array 28 or alternatively signals received via the lens 24 may be passed via a beam splitter 29 to a photodiode detector array 30.

To facilitate two channel duplex transmission, an arrangement may be used as shown in Figure 6. Referring now to Figure 6, two light sources 31 and 32 may be provided at the proximal station arranged to operate at different frequencies. Light from the sources 31 and 32 is radiated via a beam splitter 33 to a lens 34, received light being reflected from the beam splitter onto a detector 35 via a filter 36. If the source 31 is arranged to radiate at a frequency F1 and the source 32 is arranged to radiat at a frequency F2, th filter 36 may be arranged to pass only those signals at the frequency F1. At the distal location, light received at frequencies F1 and F2 is passed via a beam splitter 37 to a lens 38 at the frequency F1 and to a lens 39 at the frequency F2. The lens 39 is arranged to feed the detector 40 and the lens 38 is arranged to feed a modulator 41 and a mirror 42. Thus light at the frequency F1 is retro-reflected and modulated by the modulator 41 whilst light at the frequency F2 is locally detected at the distal station.

At the distal station the light receiver should preferably have a wide field of view so that search and acquisition is unnecessary. However, a switchable array of photodetectors as shown in Figure 7 may be provided onto which light is focussed by a lens imaging system 44. This may be used to provide wide angle coverage whilst waiting for a transmission and a narrowing of the field of view brought about once detection has occurred. This narrowing of the field of view may be effected by selecting predetermined detectors of the array 43 which may be achieved by means of associated light switches associated with the detectors. This selectivity which amounts to angular diversity, allows the rejection of high background interference such as radiation from the sun which might otherwise cause saturation or unacceptable noise.

In an alternative configuration the transmitter at the proximal location might comprise an array of transmitters all of which would be energised in order to acquire the distal transceiver. In order to reduce the transmitter beam width during data transfer, only one transmitter would be used, an array of receiver diodes ensuring that the appropriate transmitter is energised to enable automatic tracking of the distal end.

There are a large number of ways in which the foregoing techniques could be employed for two-way communication. On a battlefield for example the passive device could be mounted on an RPV which could be continuously monitored whilst data is transmitted. The technique could also be used for an IFF system where response from the passive link is automatic on receipt of a valid code sequence. A further application would be a local area network scheme where the positions of individual elements are not known. The elements might be computer stations, soldiers, vehicles, aircraft etc.

The technique may be used in surveillance applications where a remotely positioned imager is controlled from the proximal end of the link and the video data is transmitted back from the distal end.

Various modifications may be made to the arrangement shown in the drawing without departing from the inventive concept and for example a mechanical scanning system might be used to acquire and track the distal tran-

sceiver. Additionally a bandpass filter at the proximal location may be used to prevent cross-talk between up and down links.

CLAIMS

1. An optical communication system comprising two light transmitter/receiver stations positioned at spaced apart locations and arranged to afford communication therebetween, wherein one only of the two stations, hereinafter called the proximal station comprises a light transmission source, and wherein the other of the two stations, hereinafter called the distal station, comprises retro-reflector means and modulator means utilised for the transmission of data from the distal station to the proximal station by reflecting a light carrier signal originating from the light transmission source back to a receiver at the proximal station, this retro-reflected carrier signal being modulated to carry the data.

2. An optical communication system as claimed in Claim 1, in which means are included for enabling different kinds of modulation to be transmitted from each station, each station being arranged to include a receiver having a detector appropriate to the received modulation.

3. An optical communication system as claimed in Claim 1, in which both stations use phase or frequency modulation and include electronically coherent detection systems such that there is no mutual interference when both stations are transmitting at the same time.

4. An optical communication system as claimed in Claim 1, in which both stations operate in a simplex or time division multiplex mode whereby the stations are arranged to transmit alternately or at least never at the same time.

5. An optical communication system as claimed in any one of claims 1 to 4, in which the modulation is impressed on the light carier signal using, for example, Pockels, Kerr or Faraday cells, frustrated total internal reflection, electrochromic or liquid crystal cells.

6. An optical communication system substantially as hereinbefore described with reference to any one of the accompanying drawings.

CLAIMS

Amendments to the claims have been filed, and have the following effect:

Claims 1-6 above have been deleted or textually amended.

New or textually amended claims have been filed as follows:

1. A two way optical communication system comprising two light transmitter/receiver stations positioned at spaced apart locations and arranged to afford communication through free spac therebetween, wherein one only of the two stations, hereinafter called the proximal station comprises a single beam light transmission source, and wherein the other of the two stations, hereinafter called the distal station, comprises retro-reflector means and modulator means utilised for the transmission of data from the distal station to the proximal station by reflecting a light carrier signal originating from the light transmission source back to a receiver at the proximal station, this retro-reflected carrier signal being modulated to carry the data, the distal station further including an optical detector.

2. An optical communication system as claimed in Claim 1, in which means are included for enabling different kinds of modulation of the light carrier to be used by each station, each station being arranged to include a receiver having a detector appropriate to the received modulation.

3. An optical communication system as claimed in Claim 1, in which the two stations each use a different kind of modulation selected from amplitude, phase or frequency modulation and include electronically coherent detection systems such that there is no mutual interference when both stations are simultaneously modulating the optical beam.

4. An optical communication system as claimed in Claim 1, in which both stations operate in a simplex or time division multiplex mode whereby the stations are arranged to transmit alternately or at least never at the same time.

5. An optical communication system as claimed in any one of Claims 1 to 4, in which the modulation is impressed on the light carrier signal using, for example, Pockels, Kerr or Faraday cells, frustrated total internal reflection, electrochromic or liquid crystal cells.

6. An optical communication system substantially as hereinbefore described with reference to any one of the accompanying drawings.

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